
ENG-SCI 112 / EPS 112 Thermodynamics, Spring 2025

Course Description

This course takes the pedagogic approach of putting a topic of interest under the microscope and watching the concepts and formalisms of thermodynamics naturally emerge for the student. The course is very active.

Learn about how the Earth's atmosphere is structured, and test hypotheses about how energy and water move through it. Study "how they work" and "how they can work better" for different types of engines used to power planes, trains, and automobiles. Consider life, hierarchy, and the energy machinery of planet Earth. Consider the thermodynamics of your body: heart, muscles, and perspiration. And more interesting, important phenomena tackled by case study! In the process of these case studies, learn thermodynamics.

The formal statement of the course description is as follows: *Fundamental concepts and formalisms of conservation of energy and increase of entropy are explored as applied to natural and engineered environmental and biological systems.*

Prerequisite

None.

Enrollment & Lottery

3a. Enrollment in this course is limited to 18 students. It is determined by a lottery if interest exceeds the limit.

3b. For the lottery:

- [CLICK HERE](#) and complete instructions on or before 23:59, Tuesday, November 12.
- Also, be sure to add the course to your Study Card in my.harvard.edu and request enrollment permission.

3c. Students are notified about whether they may enroll in this course by 17:00 on Wednesday, November 13.

3d. Students who are not selected by the lottery are waitlisted.

Bibliography and other course materials

The course incorporates chapters 1 through 12 of the following textbook: [Cengel, Boles, Kanoglu \(CBK\), Thermodynamics: An Engineering Approach, 10th edition, McGraw-Hill, 2024](#). Depending on your preference, the publisher offers both a traditional book as well as an eBook.

Course Content

Please see [modules](#).

Before class, check the associated module. The modules serve as the "one-stop shop" for student preparation and deliverables for each class day.

Instructor

Scot T. Martin, â€‹Gordon McKay Professor of Environmental Science and Engineering and Professor of Earth and Planetary Sciences

Office hours are held on the [Zoom course link](#) on Thursdays from 12:00 to 1:00. Appointments can also be made for in-person. Professor is best for discussions about course material, including lectures and semester project, and TF is best for questions directly related to homework assignments.

Email: scot_martin@harvard.edu. Email messages are usually answered during typical work hours on customary work days.

Teaching Assistant

Manav Bansal.

Manav is a senior pursuing an S.B. in Environmental Science and Engineering. His interests lie in decarbonization technologies and energy systems, particularly carbon capture.

Email: manavbansal@college.harvard.edu. Email messages are usually answered within a few hours during normal school hours.

Meeting Times

- Classes take place two times per week on Mondays and Wednesdays from 12:00 to 1:15. The instructor stays after class for any further questions and discussion.
- Section is on Thursdays from 16:30 to 17:30.
 - Although section attendance is not mandatory, students are strongly encouraged to attend. Important information relevant to homework assignments, the midterm examination, and the semester project is presented. *A student who does not attend section but comes to office hours with questions that were covered in section receives a penalty in the context of course participation.* (To be clear, a student who does come to section and has questions in office hours about material covered in the section does not receive this penalty.)
 - See [here](#) for a further description of section.
- Although not a meeting, a related scheduling item is that homework assignments are due by 17:00 on Tuesdays. The TF provides the related section on the Thursday of the prior week. The related TF office hours are on Monday afternoon the day before the homework is due.
- Please see [modules](#) for detailed schedule of classes and course content.
- Putting all of above together, here is a typical schedule for the week:
 - Required: Monday, 12:00-1:15 all students.
 - Optional: Monday, 15:00-17:00, TF office hours, Pierce 114
 - Deadline: Tuesday, 17:00, homework.
 - Required: Wednesday, 12:00-1:15, all students.
 - Optional: Thursday, 12:00, professor office hours (Zoom).
 - Strongly encouraged: Thursday, 16:30-17:30, TF led section, Pierce 114

A Special Note on Community

Special note. As you might expect, my goal is to have a successful course. To me, this means achieving both (i) **academic excellence** in the course (which is what you expected me to write) and (ii) **building a community among us in the course** (which perhaps is not what you expected me to write). I have high expectations from all students with respect to both i and ii, but that said I also have a mindset on my part of flexibility and understanding. In the syllabus, I have set specific expectations about attendance, assignments, and so forth but at the same time you can anticipate from me flexibility and fairness if you run into out-of-the-box real-life difficulties provided that you communicate effectively and reasonably with me, preferably in advance.

Student Experience, Activities, and Deliverables

- Students should plan on approximately 10 hours of work per week outside of class time.
- Student make *posts* (one paragraph) to the Canvas course discussion board prior to class about chapter readings. See links in each module.
- Students make *individual presentations* (5 min) during class time. The schedule for different groupings so that students know the days of presentations are listed in the modules under "prior to class". Each student is responsible for **three** presentations during the course of the semester.
- *Homework assignments* are due on Tuesdays. See due dates and assignment links under "Assignments" on left panel.
- The *midterm exam* is listed in the modules.
- Deliverables for the *semester project* include an *oral presentation* and a written report in a team of 3 students.
- See further in, "[How do I succeed in this course?](#)"
- Graded items and grade breakdown are as follows:
 - Homework (40%)
 - Midterm (15%)
 - Semester project (25%; half as oral presentations and half as written documents)
 - Participation (20%)
 - The baseline grade, meaning if "you get everything right," is 96 out of 100 for homework, midterm exam, and semester project. If student work shows exceptional creativity or analysis, a grade above 96 can be earned.

- The baseline grade for participation, meaning "fulfilling all requirements well," is 90 out of 100. See below under "participation" for possible upvalues and downvalues to the baseline across the semester.
- A grade of "96" is an "A". Breakpoints are 93 between "A/A-", 90 between "A-/B+", and so on.

Homework

- Homework must be submitted by the deadline stated in the modules. **The late penalty is 20% per day.**
- **Requests for extensions** beyond the stated deadline must be approved in advance by the course instructor. The TF will refer students to consult with the course instructor about any extension requests.
- Collaboration.
 - Homework problems in the course are scaled at the level of individual work, meaning that you should not feel that you must collaborate or work in a group on the homework problems.
 - That said, you are welcome to collaborate if it fits your personality and learning style. Better learning happens that way for many types of students. It is a beautiful thing to the course instructor to imagine students in the course in a dynamic group discussion talking about course topics. You may compare answers, too. But just be sure that you know everything about the answer that you provide in your assignment in terms of understanding and calculating: that ultimate outcome is the goal of any collaboration. After discussions with peers or course instructional staff, make sure that you can work through the assignment yourself.
 - **Ensure that any answers you submit for evaluation are the result of your own efforts.**
 - **On the assignment, list the names of students with whom you collaborated.**
- You are permitted to use any materials you wish. Homework assignments are "open book," "open note," and "open internet". The expectation is that nearly all information you need appears in the course lecture notes and the assigned readings. **You must cite any books, articles, websites, lectures, etc that have helped you with your work using appropriate citation practices.** Please see special section in the syllabus for "Guidelines and rules for use of artificial intelligence like Chat GPT."

Semester Project

An important part of the course is the semester project. Student teams of 3 to 4 work together on selecting and developing projects.

Milestones and Deliverables

- **Deliverable 1.** On [February 19](#), student teams introduce several possible topics for the semester project.
- **Deliverable 2.** For March 6, write-up of 250 words as prework. The activity is appointments with individual teams for feedback. Sign up after class on [March 3](#).
- **Deliverable 3.** Presentation of current project status in the setting of peer-to-peer feedback in sections on April 17 and 24.
- **Deliverable 4.** Oral presentations are on [April 28 and 30](#). See below for further description on format and content.
- **Deliverable 5.** Write-ups are in lieu of course exam. The written report is due by 23:59 (Boston time) on May **TBD**. Per policy of FAS Registrar's Office, the due date is the date of the final exam slot for this course. The course has no final exam.

The oral presentation and written report should be organized around the following six sections:

1. **Background.** An introductory narrative of a compelling interesting and background to capture the reader's interest to continue listening to rest of oral presentation and/or to continue reading the rest of the written report. In other words, "why you and the class should be interested in this project," and how are you saving the world?
2. **Motivation.** This section should succinctly state the project goal. It should consist of one tight and excellent paragraph.
3. **Methodology.** Describe the strategy and approach of the project. In other words, "nuts and bolts of what you did and how you did it." The methodology is what you did and the results (section 4) is what you found. **Be sure to have a methodology that is centered around concepts and applications of thermodynamics.**
4. **Results.** Analysis supported by graphs is very good for this section. In other words, "what you found/observed."
5. **Discussion and outlook.** This section is "what you learned, what is your interpretation, what are the implications, and what are the uncertainties." **In addition to qualitative insights, be sure to have some quantitative statements that reflect the methodology and results.** The discussion part should for sure loop back to the project motivation of section 2. The outlook should likewise strongly link back to

the introductory narrative of section 1. The outlook should be a mix of conclusions and thinking on future directions the project could go.

6. **Author contributions.** Team members should be sure to each contribute substantially and identifiably to each deliverable of the project. Please include a section of a few sentences stating how each team member contributed to the project. There is no specific formula for how to write this section, but here are some [examples](#).

For sections 1 to 5, be sure that the central role of thermodynamics is clear to the reader.

For both the oral presentation and the written report, the grading rubric is based 65% on intellectual content related to thermodynamics and 35% on clarity in delivery, visualization, organization, and writing/presenting.

- Oral Presentations (Technical Details)
 - Oral presentations should be 15 min long, followed by 5 min of discussion, for a 3-person team. Oral presentations should be 20 min long, followed by 5 min of discussion, for a 4-person team.
 - Each slide should correspond to about 2 min of presentation (e.g., a 15 min presentation should have about 8 good slides).
 - Additional technical guidelines are [here](#).
 - Upload instructions are [here](#).
- Written Reports (Technical Details)
 - Reports should be around 20 pages for three-person teams and proportionally adjusted for teams of other sizes. A little longer or shorter than this guidance is fine as seems appropriate to the project. As rough guidance on anticipated content, a typical report has some figures and tables, so there might be on order of 14 pages of text/equations and 6 pages in figures and tables to make up 20 pages. **Reports must use TimesNewRoman font, font size 12, with line spacing of 1.2.**
 - Reports should use metric units.
 - Cited references may use any customary format.
 - Include the following question at the end of the document and provide a "yes/no" answer. *"Does your team provide permission to share the report with future course students for the purpose of helping them think about their own reports?"* The grade on the team report is independent of whether the answer is yes or no.
 - *Optional.* When doing your project, if you found any articles that you thought, "Wow, it'd be great if we had discussed that," i.e., if there is a PDF file you'd encourage for next year's students, could you let me know? A one-line addendum can be included at the end of the report that says, *"Citation XXX might be a good candidate for a focus example or semester project next year."* The grade on the report is independent of whether or not a suggestion is provided.
 - Reports should be submitted electronically to the instructor as a single PDF file (smartin@seas.harvard.edu). **IMPORTANT: Filename according to following pattern: "DayMonthYearStudentName". Example: "15May2025ScotMartin".**

Participation

Participation is a combination of both attending class and section (i.e., *œshowing upœ*) and contributing positively to those activities.

- Full attendance is required by students during the class meeting times on Mondays and Wednesdays. Specific days may be missed for reasonable reasons by communicating in advance with the instructor. Classes are not recorded.
 - One absence per semester may be requested from the instructor in advance (e.g., job interview, sports participation, and so on), and no downvalue to participation is applied. If a student misses an in-class individual presentation on that day, there is a make-up day for the presentation at the end of the semester.
 - In the case of student illness, the student should inform the instructor within 24 hours of a missed activity, and no downvalue is applied.
- **The baseline grade for participation is 90 out of 100. At the beginning of the semester, the participation grade is listed as 90 for all students in the gradebook. Any downvalues are applied during the course of the semester, and the grade may be observed to change in the gradebook. The TF keeps a ledger of downvalues, and a student may enquire with the TF about applied downvalues. Upvalues of up to +20 are applied only at the end of the semester.**
 - "Upvalues" on the baseline grade can derive from several pathways:
 - Thoughtful and reflective questions can be posted in the canvas discussion board associated with the readings of each module.
 - Individual student presentations during in-class activities can be high-quality, reflective, and thoughtful.

- Positive contributions can also manifest in Q&A in class, office hours, or section in ways that speak to an engagement with the course readings and lecture notes and to sincere thinking and reflection about the course material.
 - The instructor uses warm calling and cold calling during class time. The instructor purposely pauses with the "silent long pause" to elicit questions at certain times.
 - Students are also encouraged to interrupt the instructor with questions during lectures. The instructor is at his best when students are interacting. If the situation gets out of control or the lecture is not going forward smoothly enough, the instructor may ask folks to settle down for a few minutes ☹️.
- Consistent attendance and contribution at section is also recognized as a positive contribution to participation.
- "Downvalues" on the baseline grade accrue from omitting deliverables (e.g., in-class presentations), arriving late to class or semester project meetings, and missing class without pre-authorization from the instructor.
 - The TF checks that all students have arrived by 12:00. A downvalue of -5 is applied for arrival after 12:10.
 - Failure to present an in-class presentation has a downvalue of -10.
 - A student should miss no more than two posts to the discussion board during the semester. Beyond two, a downvalue of -3 is applied per instance.
 - For assignments due at 9 AM and presented at noon, in the case of a tardy submission a downvalue of -1 is applied a 9 AM, again at 10 AM, and again at 11 AM.

Guidelines and rules for use of artificial intelligence like Chat GPT

Within this class, you are welcome to use generative models (ChatGPT, GPT, DALL-E, Stable Diffusion, Midjourney, GitHub Copilot, and anything after). They might be part of future. They may make it possible for you to submit assignments at higher quality and in less time. Do keep in mind, however, that all generative models have a tendency to make up incorrect facts and fake citations. You are ultimately responsible for any inaccurate, biased, offensive, or otherwise unethical content you submit as course work regardless of whether it originally comes from you or a generative model.

Several restrictions and requirements for use of generative models in the course are as follows:

- **Homework.** These models may be used for a maximum of one question on each homework assignment. Acknowledgment must be made, as follows:
 - If output of generative AI is used word-for-word (i.e., verbatim): "Source: Prompt engineering by [INSERT YOUR NAME HERE] of [MODEL, e.g., "Chat GPT-4"], accessed 22 January 2025".
 - If output of generative AI is used but with modifications of some or many words: "Source: Prompt engineering and modifications of results by [INSERT YOUR NAME HERE] of output from [MODEL], accessed 22 January 2025". Also show the original response by the AI (page one) and your updated version using 'track changes' (page two).
 - If output of generative AI was an inspiration but words are entirely your own: "Source: Written by [INSERT YOUR NAME HERE]. Inspired by output from [MODEL] with prompt engineering [INSERT YOUR NAME HERE], accessed 22 January 2025".
- **Presentations.** Generative models may be used. Acknowledgment must be communicated along the style and intentions outlined in the sub-bullets above for homework.
- **Exams/Semester Project.** Generative models may not be used for exam or semester projects.

If in doubt on any items, please consult with the instructor. Keep in mind that generative models are new for all of us, and clarifications can be expected.

Acknowledgment. This statement was adapted from material written by Ryan Baker, University of Pennsylvania (<https://learninganalytics.upenn.edu/ryanbaker/foundationmodel-class-policy-v1.pdf>, accessed 5 June 2023).

Statement on diversity, inclusion, and belonging

The intention is that students from all backgrounds and perspectives feel inclusion and belonging and be well-served by this course, that students' learning needs be addressed, and that the diversity that the students bring to this class be a resource, strength, and benefit. Materials and activities are intended to be respectful of gender identity, sexuality, disability, age, socioeconomic status, ethnicity, race, nationality, religion, and culture. In this regard, please communicate with me about ways to improve the effectiveness of the course for you personally or for other students or student groups. Your suggestions are encouraged and appreciated.

Acknowledgment. This statement was adapted from material written by L. Hernandez, Behavioral and

Political Statements

Class time is dedicated to the instruction of thermodynamics. Please respect the dedication to this purpose by the instructor and the commitment of other students to it by not using any class time for making political statements, including those related to any campus protest activities.

Publishing or Distributing Course Materials

Students may not post, publish, sell, or otherwise publicly distribute course materials without the written permission of the course instructor. Such materials include, but are not limited to, the following: lecture notes, lecture slides, video, or audio recordings, assignments, problem sets, examinations, other students'™ work, and answer keys. Students who sell, post, publish, or distribute course materials without written permission, whether for the purposes of soliciting answers or otherwise, may be subject to disciplinary action, up to and including requirement to withdraw. Further, students may not make video or audio recordings of class sessions for their own use without written permission of the instructor.